On the Causes of Rotation of the Vertebræ in Scoliosis.

By

F. MUIRHEAD LITTLE, F.R.C.S.

Assistant to the National Orthopædic Hospital, &c., &c.

A Paper read at the International Medical Congress (in the section of Orthopædic Surgery) in Berlin, 1890.

Reprinted (with additions), from the "Lancet"

London:

JOHN BALE & SONS,

83, 84, & 85, GREAT TITCHFIELD STREET, OXFORD STREET, W.

1891

On the Causes of Rotation of the Vertebræ in Scoliosis.

By E. MUIRHEAD LITTLE, F.R.C.S.

Surgeon to the National Orthopædic Hospital, &c., &c.

THE question, What is the cause or what are the causes of rotation of the vertebræ in scoliosis, or so-called lateral curvature of the spine? has always been a troublesome one to answer, and although for many years the subject has been fruitfully studied by orthopædic surgeons both in Europe and America I believe that we may say that the question has never been fully and satisfactorily answered. Mr. Alexander Shaw, the author of the article on "Curvatures of the Spine" in the first two editions of Holmes's *System of Surgery*, and whose labours on the subject have left us his debtors, held that rotation was due to alterations in the articular processes caused by unequal pressure on the two sides of a spine which was from one cause or another bent to one side. Dr. Judson, of New York, in 1877 put forward the view that rotation is a normal accompaniment of flexion in the healthy spine, and that it is greater or less according as the curvature is greater or less, and that its occurrence in health or disease is due to the fact that the bodies of the vertebræ which project into the cavity of the thorax and abdomen are more free to move laterally than are the spinous pro-

cesses, which are "entangled in the posterior parietes composed of ribs, muscles and fasciæ." The permanent rotation he holds to be merely an exaggeration of the normal. He points out that (as is undoubtedly the case usually) rotation takes place round an axis outside the column and posterior to it. In those cases where there is no deviation of the apices of the spinous processes from the mid-line, the axis is, of course, situated in the line of the apices of those processes.

Mr. W. A. Lane in an ingenious paper read before the Royal Medico-Chirurgical Society in 1889, drew attention to the fact that in the case of inequality of the lower limbs, or persistent standing on one leg, the plane of the upper articular surface of the sacrum is rotated from the horizontal round an oblique axis, instead of round a transverse one as is the case in the erect position when standing equally on both legs which are of the same length. He holds that this obliquity is the cause of rotation in the spinal column above.

Dr. Judson's statement that rotation is a normal accompaniment of lateral flexion appears to me insufficiently supported by facts, and the want of outside support to the anterior portion of the column which he adduces as a reason for this rotation can hardly be allowed much weight as a cause when we remember how firmly the bodies are tied together by strong and inelastic ligaments, and that the whole of the posterior half at least of each vertebral lever, and not only the apices of the spinous processes, are supported by the ribs and muscular and fibrous masses which form the parietes. The ribs, it must be remembered, actually and directly support the bodies themselves, although their support is placed rather far back.

Mr. Lane's hypothesis, while it might help to explain the appearance of rotation in a single curve with its convexity

towards the most used limb (in most cases of scoliosis towards the right, that is to say) a direction opposite to that usually taken by single curves, and while it might account for the rotation in the compensatory thoracic curve, tells directly against the production of rotation in the direction in which it occurs in single curves or in the primary lumbar curve. On Mr. Lane's hypothesis the spinous processes in this latter region should deviate from the middle line *more* than do the bodies, instead of *less*.

It appears to me that none of the before-mentioned explanations cover the whole ground; although Mr. Shaw's goes the furthest towards doing so, it does not account for the very early appearance of rotation when as yet the spinous processes have scarcely deviated from the straight line.

These theories fail also to account for those cases, such as that of Dr. Gideon Mantell (*Med. Chir. Trans.* 1854), where there is absolutely no deviation of the spinous processes from the middle line to be detected. Neither do they account for the absence of rotation in many cases of true lateral curvature caused by inequality of the lower limbs, and by disease of the thoracic viscera.

Mr. Warrington Haward attributes rotation to the action of some of the erector muscles of the spine when acting habitually much more strongly on one side than the other.

Many other authors have advanced theories to account for the distortion, but those mentioned are the most plausible. Jules Guerin, for instance, considered that spasm of the muscles on the concavity caused rotation, and carried his theory into practice by performing subcutaneous myotomy.

In all diseases, whether they most concern the physician or the surgeon, it is to the evidence from the dead-house that we look to solve the difficult problems that they

present, and this is more especially true of diseases involving the skeleton and those in which mechanical problems are the most important. In scoliosis, however, it is very rarely that we have an opportunity of dissecting the subject, for the disease is not a directly fatal one, and most of the few recorded necropsies have been on advanced cases of great deformity, the subjects having died by accident, or from some disease long after the beginning of the distortion.

These considerations have led me to make some observations on the spine in children and young adults in order to find out under what circumstances, if any, rotation can occur in the dorsal and lumbar regions of the column.

My first observations were made on the normal spine in the living, in order to ascertain whether rotation normally accompanies lateral flexion.

I found that in the erect position, both in children and adults, on extreme voluntary lateral flexion of the spine apparent rotation occurred; but that this appearance of rotation was due to the muscles on the convexity contracting to support the trunk, and that it did not appear when flexion was produced voluntarily or passively in the prone position, although the flexion was such that the spinous processes deviated from the straight line as far as in extreme scoliosis.

I next examined the phenomena of lateral flexion in the dead body, in which, however, the natural conditions were so far altered that the sternum and cartilages of the ribs had been removed, together with all the viscera. On forcibly bending the trunk laterally, the body resting on its back, no rotation accompanied the movement, and I then divided the anterior common ligament between each of the vertebræ, and finally also the intervertebral discs and posterior common ligament, without, however, succeeding in producing any evident rotation.

The next experiments were undertaken with a view to determine the effect of vertical pressure on the spinal column in producing flexion and, if possible, rotation. The scarcity of available subjects in London prevented my trying this on the trunk as a whole, and I had to content myself with experiments on the dorsal and lumbar regions of the spine removed from the body *en masse*, with portions of the ribs *in situ*. The subjects were children of from three to seven years of age. The spine was placed on a carpenter's bench, its posterior surface resting as far as regards the dorsal region on the bench, and pressure was applied by means of a powerful wooden screw cramp.

A single general curve was the result without rotation.

The twelfth dorsal vertebra was then held in the middle line by a cord, and pressure again applied.

A double curve was thus produced, the radius of which in the dorsal region in one case was only seven centimetres, the transverse processes nearly touching on the concavity. There was no rotation, the line of the spinous processes being as curved as that of the bodies.

I now examined the effect of fixing the spinous processes in the middle line by inserting them into a narrow groove in a piece of deal. Pressure was applied until the wood gave way, without producing rotation. Oak was then substituted for deal, and as much force applied as possible, but distinct rotation was not produced.

The ends of the ribs were removed, and first the anterior common ligament and afterwards the discs and posterior common ligament and all the tissues between the transverse processes on one side were divided, but the result was still negative.

On removing the spine, a very slight twisting effort of the hands was enough to separate it into two or three portions, with separation of the bodies of the vertebræ.

The principal obstacles to this rotation appeared to be in the articular processes, which obstacle was overcome by the overriding of the superior by the inferior processes of the vertebra next above, with consequent separation of the vertebræ. In the spine with the ligaments intact the greatest twisting force that I could apply with my hands did not produce at most a greater rotation than 25°.

It would thus appear that, while a certain limited amount of rotation is possible in the normal spine, it is not a normal accompaniment of flexion, and, indeed, that it is difficult to produce artificially. We know also that in lateral curvature of the spine, resulting from pleuritic adhesions, rotation is absent, as it is also in those temporary curves which occur in those whose lower limbs are of unequal length.

It is surely a fair inference to draw from the foregoing observations that there is some pathological condition present in scoliosis from the first which allows of the gradual production of rotation, and this condition I believe to be a certain tendency of the ligamentous structures to yield, that is generally known as want of tone, and which is evidenced in the flat-foot which so often accompanies it. But this laxity of the fibrous structures is not enough to account for rotation, and I believe that it is to the muscles that we must look for an explanation. On the first occurrence of lateral yielding of the column the erector muscles of the spine are called into play to correct the deformity and maintain the spine in the erect position, and the muscles situated on the convex side of the curve have obviously to perform the greater amount of work. Of these muscles, some, such as the spinalis dorsi, are attached at both ends almost entirely to points in the middle line; these can have little effect in producing rotation, although they may, and do tend to keep the

spinous processes in the straight line. Others, however—and these form a large part of the muscular mass occupying the vertebral groove—are attached at one extremity to the middle line, and at the other to the transverse processes, and the angles of the ribs, running obliquely from one part of the vertebral column to another. Such are the erector spinæ, longissimus dorsi and sacro-lumbalis, multifidus spinæ, semi-spinalis dorsi, and rotatores spinæ.

Now it is obvious that when the muscles of both sides act equally to straighten the spine there is no tendeney to produce rotation. When, however, there is a lateral yielding of the spine the muscles on the convexity alone are called into action; and although they tend to straighten the line of spinous processes, they have, as Mr. Haward has pointed out, also a distinct rotatory action, which, long exerted on a column whose fibrous tissues are inclined to yield, produces a twisting, their action being unbalanced by any muscles on the anterior portion of the spinal column. Absorption of bone takes place where there is constant pressure, and adaptive secondary deformity of the articular processes and bodies follows, while in some cases the transverse processes are even bent in towards the middle line. This process, as we see it going on in the living subject, is of course a most gradual one, the change being almost imperceptible from month to month, but that such a force as that exerted by the muscles must tell in time must be admitted. It appears probable that some alteration in the nutrition of the bone occurs in these cases, perhaps such as the "late rickets" described by Macewen, but I am not aware that any direct evidence of this has been produced.

If the muscles then play as important a part in the production of this deformity as I believe that they do, it is evident that the gymnastic exercises so generally recommended must be very judiciously selected and moderated.

It is of little use for the patient to join a class at a gymnasium where the supervision is only general. She must go through the prescribed exercises under the particular and constant supervision of a properly instructed person, whether a parent, nurse or teacher, in a warm room and when practicable naked to the waist. The individual efforts to be made must be small and such as can be easily performed. The surgeon must see for himself from time to time that his orders are properly carried out.

It is of course only in the early stage that marked benefit can be hoped for. In the later stages, where there is much rotation and deformity of the ribs, we may hope to arrest the progress of the distortion with the various means at our command, but we cannot remove it. The direct application of force to the displaced bones is unfortunately not practicable.

18, Park Street, W.,
February, 1891.